

PATENT

MODULAR HUMAN HABITAT SIMULATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a modular human habitat simulator for use on Earth to provide an environment that approximates, in a controlled test situation, a number of conditions expected to exist when an inflatable modular human habitat is deployed into Earth orbit.

2. Description of the Prior Art

Simulators serve the function of providing an environment that approximates, in a test situation, phenomena and/or conditions likely to occur in actual performance of the apparatus being simulated. Naturally, the apparatus being simulated can be based on a counterpart such as cockpit for an aircraft or a spacecraft, or an object that has no counterpart such as a fantasy amusement park ride.

As to amusement rides, these simulators can provide visual presentations and motion as illustrated by U.S. Pat. No. 5,791,903 to Feuer, et al and U.S. Pat. No. 5,453,011

1 to Feuer, et al. In this application, the simulator can  
2 provide the passenger with the feeling of motion such as  
3 angular rotation about a roll axis and limited angular  
4 rotation about a pitch axis. Further, visual simulation  
5 can be incorporated to enhance the effect of movement.

6 Simulators for aircraft and spacecraft are also well  
7 known as typified in U.S. Pat. No. 4,347,055 to Geiger,  
8 U.S. Pat. No. 4,678,438 to Vykukal, and U.S. Pat. No.  
9 5,616,030 to Watson. In these applications, effects such  
10 as weightlessness and restrictions such as the dimensions  
11 of the environment are simulated as close as possible to  
12 the actual environment. To further enhance the simulation  
13 these simulators typically include instrument readouts to  
14 augment the effect of being in an actual aircraft or  
15 spacecraft.

16 Due to the numerous types of aircraft and spacecraft  
17 designs, there are a variety of conditions of interest that  
18 may be tested by simulators tailored for each individual  
19 type of craft. Thus, while it is possible that certain  
20 tests can be applied to a multitude of cases, there is no  
21 single simulator that can address all the possible  
22 environments of the numerous crafts available. Against  
23 this backdrop perhaps the greatest variation occurs with  
24 regards to the internal dimensions and volume of each  
25 potential simulated environment.

26 Inflatable modular habitats are not new as evidenced  
27 by U.S. Patent No. 6,231,010 to Schneider, et al, and U.S.  
28 Patent No. 6,547,189 to Raboin, et al. Inflatable modular  
29 human habitats have been proposed as a more cost effective  
30 way to deploy a space station. This is primarily driven by  
31 two factors.

32

1 First, the modular habitat has an inflatable shell and  
2 thus does not weigh as much as a structure that has a rigid  
3 shell. This is important considering the present high cost  
4 for placing an object into space. Currently, this cost is  
5 of the order of \$10,000.00 per pound to place an object  
6 into Earth orbit. As a result, the inflatable modular  
7 habitat is less expensive to deploy into orbit.

8 Second, a rigid shell structure has a volume that is  
9 the same on Earth as in space. The modular habitat expands  
10 in space and thus offers the opportunity for a larger  
11 internal volume while in orbit. This increased volume is  
12 desirable to house more crewmembers and equipment.

13 While inflatable modular habitats are well known,  
14 there is a need for an inflatable modular habitat simulator  
15 that serves the function of providing an environment that  
16 approximates, in a controlled test situation, a number of  
17 conditions expected to exist when the module is deployed  
18 into Earth orbit or space. Situations can be addressed  
19 that concern, for example, the placement of equipment,  
20 sleeping quarters, location and testing of life support  
21 systems, placement of various cylinders inside and outside  
22 of the module, lighting, and location of floor structures.  
23 These considerations coupled with others, such as, amount,  
24 location, and capacity of gas, liquid and power lines would  
25 allow crews and systems engineers to better understand how  
26 best to utilize the resources and room within the module  
27 long before it is in orbit. What is needed is a simulator  
28 that reproduces a variety of conditions in a test  
29 environment on Earth, including the internal dimensions and  
30 volume of a deployed inflatable modular human habitat, that  
31 the habitat is likely to experience in space.

32

1 BRIEF SUMMARY OF THE INVENTION

2           This invention is directed to a modular human  
3 habitat simulator having a housing with a rigid wall  
4 defining an internal volume, a longitudinal axis, a first  
5 and second opposing openings along the longitudinal axis,  
6 the rigid wall having an exterior surface generally the  
7 shape of an exterior surface of a deployed inflatable shell  
8 of a modular human habitat, the rigid wall having an  
9 interior surface of generally the shape of an interior  
10 surface of a deployed inflatable shell of a modular human  
11 habitat, and the internal volume being substantially that  
12 of a deployed inflatable modular human habitat volume.  
13 There is a first distal enclosure, having a passage  
14 therethrough, connected to the housing such that the  
15 passage aligns with the first opening of the housing, and a  
16 second distal enclosure connected to the housing such that  
17 a passageway exists into the second opening of the housing.  
18 Also, there is at least one longeron fixedly attached to,  
19 and extending from, the first distal enclosure through the  
20 internal volume and fixedly attached to the second distal  
21 enclosure.

22 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

23           Fig. 1 is a partial cut-away isometric view of the  
24 modular human habitat simulator with the opposing distal  
25 ends not attached to the housing;

26           Fig. 2 is a partial cut-away isometric view of the  
27 modular human habitat simulator with the opposing distal  
28 ends attached to the housing;

29           Fig. 3 is a partial cut-away isometric view of a  
30 deployed inflatable modular human habitat identifying the  
31 shape of the habitat shell;

1        Fig. 3a is another partial cut-away isometric view of  
2 a deployed inflatable modular human habitat identifying a  
3 second type of shape of the habitat shell;

4        Fig. 3b is another partial cut-away isometric view of  
5 a deployed inflatable modular human habitat identifying a  
6 third type of shape of the habitat shell;

7        Fig. 4 is a partial cut-away isometric view of a  
8 modular human habitat simulator;

9        Fig. 4a is another partial cut-away isometric view of  
10 a modular human habitat simulator identifying the debris  
11 shield and location of storage and cylinders;

12       Fig. 5 is a partial cut-away isometric view of a  
13 modular human habitat simulator identifying water bags and  
14 panels;

15       Fig. 5a is an isometric view of a core's longerons  
16 with panels;

17       Fig. 6 is a partial cut-away aerial isometric view of  
18 a modular human habitat simulator showing a floor  
19 structure;

20       Fig. 6a is a partial cut-away isometric view of a  
21 modular human habitat simulator;

22       Fig. 6b is a partial view of the floor straps;

23       Fig. 6c is a partial view of a rounded floor strap  
24 assembly;

25       Fig. 6d is a cut-away side view of a strap and tension  
26 bars;

27       Fig. 6e is a side view of a tension bar;

28       Fig. 7 is another partial cut-away isometric view of a  
29 modular human habitat simulator identifying the floor  
30 structure;

1        Fig. 7a is a partial cut-away isometric view of a  
2 modular human habitat simulator showing multiple floor  
3 structures;

4        Fig. 7b is a partial cut-away aerial isometric view of  
5 a modular human habitat simulator showing support for a  
6 floor structure;

7        Fig. 7c is a cross sectional side view of a modular  
8 human habitat simulator showing a floor structure in  
9 relation to the longerons;

10       Fig. 7d is a cross sectional side view of a support  
11 beam;

12       Fig. 7e is an isometric view of a segment of the floor  
13 structure;

14       Fig. 8 is a partial cut-away isometric view of the  
15 first distal enclosure;

16       Fig. 9 is a partial cut-away isometric view of the  
17 second distal enclosure having one opening;

18       Fig. 9a is a partial cut-away isometric view of the  
19 second distal enclosure having two openings;

20       Fig. 10 is a isometric view of a housing segment;

21       Fig. 11 is an isometric view of a number of housing  
22 segments joined together; and

23       Fig. 12 is a partial cut-away isometric view of the  
24 distal housings.

## 25 DETAILED DESCRIPTION OF THE INVENTION

26       The present invention may best be understood by  
27 reference to the following description taken in conjunction  
28 with the accompanying drawings. Fig. 1 is a partial cut-  
29 away isometric view of the modular human habitat simulator  
30 110. The modular human habitat simulator 110 is comprised  
31 of a housing 112 that has a rigid wall 114 defining an  
32 internal volume 130, a first opening 116 and a second

1 opening 118, and an external surface 120 and an interior  
2 surface 124. The housing 112 provides, for example,  
3 shelter for a crew, an enclosure for storage of materials  
4 and/or equipment, and an enclosed area for containing  
5 equipment. Along with the housing 112, there is a first  
6 distal enclosure 122 having a passage 128 extending through  
7 the enclosure, and a second distal enclosure 126. At least  
8 one longeron 132 is identified, however the modular human  
9 habitat simulator 110 does not require a fully functional  
10 longeron 132 as would be employed in a deployed modular  
11 habitat. These longerons 132 can be fully functional,  
12 partially functional, or non-functional and thus merely  
13 incorporated to indicate the existence of a longeron in the  
14 simulator. In the preferred embodiment, there are four  
15 longerons 132 and each longeron is at least partially  
16 functional. That is, each longeron has a degree of  
17 structural integrity that allows it to assist in supporting  
18 a floor.

19 The distal enclosures are hollow and can be used as a  
20 simulated airlock to another craft, a passage 128 into the  
21 internal volume 130, and/or storage. The rigid wall 114  
22 can be of any rigid material including metal, metal  
23 composite, or other type of non-metal rigid matter. In the  
24 preferred embodiment, the rigid wall 114, and the first  
25 distal enclosure 122 and the second distal enclosure 126  
26 are made of steel. In an alternative embodiment, the wall  
27 may also be a substantially rigid wall where the wall  
28 exhibits some degree of flexibility. In such a case, the  
29 substantially rigid wall may be of a composite material or  
30 an alloy that allows for a certain amount of movement.

31 Turning now to Fig. 2, the elements of the modular  
32 human habitat simulator 110 are assembled showing how

1 access to the internal volume 130 is achieved through the  
2 passage 128 in the first distal enclosure 122. The passage  
3 128 runs through the first distal enclosure 122 between the  
4 opening 180. In this figure, there are two longerons 132  
5 that serve to connect the first distal enclosure 122 and  
6 the second distal enclosure 126. However, any number of  
7 longerons 132 may be used as is required by the given  
8 situation. Furthermore, the shape of the interior surface  
9 124 and external surface 120 in Figs. 1 and 2 is not  
10 restricted to that displayed in the figures as will be  
11 discussed.

12 The first distal enclosure 122 and second distal  
13 enclosure 126 are connected to the housing 112 by known  
14 conventional means. In the preferred embodiment, the  
15 distal enclosures are made of steel and connection is  
16 accomplished by welding the first distal enclosure 122 and  
17 the second distal enclosure 126 to the housing 112.

18 Referring to Fig. 3, a cross-sectional view of a  
19 modular habitat 134 as would be deployed in space is shown.  
20 The shape of the deployed modular habitat is substantially  
21 different than from the shape of a non-deployed modular  
22 habitat. In the non-deployed state, the modular habitat is  
23 compressed to fit within a casing on a rocket or within a  
24 shuttle. Once deployed, the modular habitat is inflated  
25 into a deployed shape. The shape of the deployed  
26 inflatable shell 136 bulges out and substantially around  
27 the distal enclosures 140. In Fig. 3a, the deployed  
28 inflatable shell 136 has a shape different than that in  
29 Fig. 3. The shape of the deployed inflatable shell 136 in  
30 Fig. 3a does not tend to wrap around the distal enclosures  
31 140. As Fig. 3b shows, the shape of the deployed  
32 inflatable shell 136 has more of a bulge toward the center



1 of the deployed inflatable shell 136 than in either Fig.3  
2 or Fig. 3a. Figures 3, 3a, and 3b are representative of  
3 wide variety of shapes that a deployed inflatable shell 136  
4 can assume depending upon the choice of variables such as  
5 the size of the deployed inflatable shell 136 and  
6 longitudinal length between the distal enclosures 140. It  
7 naturally follows, that the shape of the deployed  
8 inflatable shell internal surface 168 is thus driven by the  
9 parameters that dictate the overall shape of the deployed  
10 inflatable shell 136.

11 As Figs. 3, 3a, and 3b indicate, the shape of a  
12 modular habitat 134 deployed inflatable shell 136 is not  
13 restricted to a single profile. As a result, in  
14 referencing Figs. 1 and 2, the shape of the interior  
15 surface 124 of the modular human habitat simulator will be  
16 dependent upon the anticipated shape of a deployed  
17 inflatable shell of a modular habitat, and in particular  
18 the anticipated resulting shape of a particular deployed  
19 inflatable shell internal surface 168 as exemplified in  
20 Figs. 3, 3a, and 3b. This is the reason that the interior  
21 surface is generally the shape of the deployed inflatable  
22 shell internal surface of a specific modular habitat.  
23 Furthermore, as there are a variety of shapes available,  
24 the internal volume 130 identified in Figs. 1 and 2 would  
25 be substantially the internal volume of a deployed  
26 inflatable modular human habitat. Naturally it follows  
27 that the internal volume of the simulator will be dependent  
28 upon a number of factors characteristic of a particular  
29 deployed module such as the longitudinal length of the  
30 module and the shape of the shell of a deployed inflatable  
31 modular human habitat. Furthermore, the internal shape of  
32 the shell of a particular module habitat is not necessarily

1 fastener. As illustrated, there are two circumferential  
2 strap assemblies. Again, they are referred to as the first  
3 and second circumferential strap assemblies. Fig. 10  
4 illustrates how the zipper would engage and thereby fasten  
5 the circumferential strap assemblies 138 to the radial  
6 strap assembly 144. Turning now to Fig. 14, the tape 126  
7 is sewn 146 to a strap 106. When the zipper teeth 130 are  
8 engaged, the straps 106 overlap 148. This overlap helps to  
9 insure that the bladder 150 is not pinched or cut by the  
10 zipper. In an alternate embodiment, the straps do not  
11 overlap, but rather meet side by side to protect the  
12 bladder from the zipper.

13 Addressing now Fig. 15, the flexible restraint layer  
14 146 covers the bladder 150. The restraint layer 146 and  
15 the bladder 150 are securedly fastened to the fore 152 an  
16 aft 154 assemblies while the longerons 156 separate the  
17 fore and aft assemblies. Fastening of the bladder to the  
18 fore and aft assemblies is accomplished by known means such  
19 as the use of end rings and/or attachment rings. The fore  
20 and aft assemblies and the longeron compose the rigid  
21 structural core. In the preferred embodiment, there are  
22 four longerons 156, the fore assembly 152 is an airlock  
23 that is adapted to hold the strap loops 112 securedly in  
24 place by known conventional means such as the use of  
25 rollers or a bar, and the aft assembly 154 is used  
26 primarily for storage, but also has the same means for  
27 securing the strap loops 112. Also, the fore and aft  
28 assemblies are adapted to secure the bladder in place. In  
29 an alternative embodiment, the aft assembly 154 may also be  
30 an airlock. Further, in the preferred embodiment, the fore  
31 and aft assemblies are made of steel and the longerons are

1 In the case where the longerons are made of steel securing  
2 is accomplished by use of techniques such as welding or  
3 nuts and bolts.

4 Fig 4 also depicts a portion of a simulated debris  
5 shield 144. A fully deployed modular habitat would,  
6 typically, have a debris shield covering the majority of  
7 the outside perimeter. This shield is a protective barrier  
8 against impacts from particles or penetration by radiation.  
9 In the modular human habitat simulator 110, only a portion  
10 of the debris shield is identified as being fixedly  
11 attached to the external surface 120 and this portion may  
12 or may not be functional as the case dictates. The portion  
13 of the simulated debris shield is fixedly attached by  
14 conventional methods including, but not limited to, the use  
15 of adhesives, restraints such as rope and hooks, fasteners,  
16 bolts and screws, snap-tight locking devices, or hooks and  
17 eyeholes.

18 In Fig. 4a, a number of cylinders 154 are placed  
19 within the first distal enclosure 122, second distal  
20 enclosure 126, and internal volume 130 of the housing 112.  
21 The cylinders 154 simulate the storage requirements of  
22 gases and liquids during deployment of a modular habitat  
23 134 in space. The number, and location, of the cylinders  
24 154 is dependent upon the mission and experimental  
25 scenario.

26 When a modular habitat is deployed, there are a number  
27 of safety features present for the protection of the crew.  
28 One such feature is the use of water to assist in absorbing  
29 certain forms of radiation. Turning to Fig. 5, a number of  
30 simulated water bags 146 are deployed about the interior  
31 surface 124 of the modular human habitat simulator 110.  
32 This provides those working within the simulator the

1 opportunity to work in an environment that, in space, would  
2 likely have such bags in the deployed modular habitat. The  
3 simulated water bags 146 are constructed from materials  
4 that are light weight and pliable enough to conform to the  
5 geometry of the interior surface 124. In the preferred  
6 embodiment, the simulated water bags 146 are made of a  
7 substantially pliable foam substance such as polyurethane.  
8 The simulated water bags are fixedly attached to the  
9 interior surface 124 by any number of means including, but  
10 not limited to, adhesives, fasteners such as VELCRO®, rope  
11 and hooks, bolts and screws, snap-tight locking devices, or  
12 hooks and eyeholes.

13 Another such safety feature is the use of panels.  
14 Fig. 5a illustrates how panels 148 are attached to a core  
15 208 in a configuration before launch. The panels 148 serve  
16 the function of providing a structure to hold the un-  
17 inflated shell of a modular habitat in place during  
18 deployment. After deployment, the panels 148 can be re-  
19 positioned within the inflated shell. Returning to Fig. 5,  
20 the figure shows how the simulated panels 164 are placed  
21 about the interior surface 124 of the housing 112. In the  
22 preferred embodiment, the simulated panels 164 are also  
23 made of a substantially pliable foam substance such as  
24 polyurethane. The simulated panels are fixedly attached by  
25 the same methods described above for attaching the  
26 simulated water bags 146.

27 Addressing now Fig. 6, there is a floor structure 150  
28 disposed within the internal volume 130 of the modular  
29 human habitat simulator 110. Referring to Fig. 6a, the  
30 presence of the floor structure 150 divides the internal  
31 volume 130 into an upper internal space 152 and a lower  
32 internal space 154. In the preferred embodiment there are

1 three floor structures 150 that divide the internal volume  
2 130 into four internal spaces.

3 Figs. 6 and 6a also shows the floor structure 150  
4 extending along the longitudinal axis from approximately  
5 end to end of the modular human habitat simulator 110. In  
6 the preferred embodiment, this is the chosen configuration.  
7 By running longitudinally, the crew has a greater degree of  
8 depth perception in the modular human habitat simulator  
9 110. This longitudinal arrangement promotes a better  
10 psychological environment for the crew and more efficient  
11 access to equipment placed on, or within the proximity of,  
12 the interior surface 124. Access to different levels of  
13 floor structures is accomplished through at least one  
14 access opening 156. Conventionally known means, such as  
15 but not limited to stairs, ladders, and ropes, are  
16 available to transcend to other levels through the access  
17 opening.

18 The floor structure 150 is comprised of a plurality of  
19 floor segments 158 as identified in Fig. 6. Turning to  
20 Fig. 6b, in the preferred embodiment each floor segments  
21 158 is made of interlaced flooring straps 210. Each  
22 flooring strap 160 runs from one side of the floor segments  
23 158 to the other side. There are a number of ways in which  
24 the individual flooring straps can be interlaced to form  
25 each floor segments as would be apparent to those of  
26 ordinary skill in the art. By removing a floor segment  
27 158, an access opening 156 can be created for the crew to  
28 transcend from one level to another.

29 In the case of Fig. 6c, where there is a rounded side  
30 162, certain of the flooring straps 160 terminate on posts  
31 234 on the rounded side 162. Figs. 6d and 6e identifies

1 how the straps 160 wrap around the tension bar 218, which  
2 is similar to the wrap around the posts in Figs. 6d and 6e.

3       Returning now to Fig. 6b, the tension bars 218 provide  
4 the primary support for the interlaced flooring straps 210  
5 and forms at least one side of the floor segments 158. As  
6 shown in Figs. 6d and 6e, each flooring strap 160 end that  
7 attaches to a tension bar 218 does so by wrapping around  
8 the tension bar. Focusing again on Fig. 6b, each tension  
9 bar 218 has a plurality of holes 224. The holes 224 are  
10 aligned with a number of bolts 220 that are secured in  
11 place along the any number of structures including, but not  
12 limited to, a longeron 132, support beam, or a secondary  
13 bar. In the case of a secondary bar, the secondary bar is  
14 secured in place by being attached to, for example, a  
15 longeron 132, the interior surface 124 of the housing 112,  
16 or a support beam 176. Attachment of the secondary bar is  
17 accomplished in a number of ways including, but not limited  
18 to, welding.

19       In proceeding to secure each floor segments 158, the  
20 bolts 220 fit through the holes 224 of the tension bars  
21 218. Once the bolts are inserted, nuts 222 are applied to  
22 the bolts 220. As the tension bars 218 are secured in  
23 place by tightening the nuts 222, the interlaced flooring  
24 straps 210 are tightened and become taut or semi-taut.  
25 This taut or semi-taut condition provides support for a  
26 person to walk on the interlaced flooring straps 210.

27       Returning to Fig. 6, adjacent floor segments 158 that  
28 are not bordered entirely by the tension bar are held  
29 together by conventional connection means such as  
30 carabiners 228, being tied together by rope or cord, or  
31 other such means. This is the preferred embodiment for

1 adjacent floor segments 158 that do not utilize tension  
2 bars 218.

3 In a deployed module, the floor structure 150 might  
4 not be of the form of a taut or semi-taut flexible webbing  
5 or solid material. This is because the low gravity  
6 environment anticipated for the deployed module does not  
7 necessarily require a floor structure to be solid as would  
8 be the case on the surface of the Earth. The floor  
9 structure in the modular human habitat simulator is subject  
10 to Earth's gravity and thus a floor is needed that can  
11 support a persons' weight. Thus, flexible materials can be  
12 used, as in the case of taut interlaced flooring straps,  
13 for the floor structure.

14 Depending upon the type of experimentation conducted  
15 within the modular human habitat simulator, it may be  
16 desirable to use a flexible and non-rigid floor structure.  
17 In another embodiment, the floor segments are made of a  
18 metal or metal composite or alloy. The floor segments can  
19 be solid or perforated with holes to reduce weight. Other  
20 materials having a flexible yet sturdy characteristic such  
21 as graphite composites may also be used as dictated by the  
22 desired environment. By removing a floor segments an  
23 access opening can be provided for a crewmember to  
24 transition between the different levels within the housing  
25 created by the various floor structure in the same way as  
26 for the strap based floor structure discussed above.

27 Turning now to Fig. 7, the floor structure 150 is  
28 rigid or substantially rigid and composed of a metal or  
29 metal alloy. Again, a floor segments 158 can be removed to  
30 provide an access opening 156 to another level within the  
31 housing 112. The floor segments 158 are supported in place  
32 by the longerons 132 and support beams 176. In an

1 alternative embodiment, the modular human habitat simulator  
2 110 does not incorporate any longerons, in which case the  
3 floor segments 158 are supported by the support beam 176.

4 Addressing now Fig. 7a, three levels of floor  
5 structures 150 are used in the modular human habitat  
6 simulator 110. The lowest level floor structure is  
7 supported primarily by support beam 176 attached to the  
8 bottom of the interior surface 124.

9 Addressing now Fig. 7b, a plurality of floor  
10 structures 150 are viewed from an aerial perspective. The  
11 floor structure 150 is supported by a number of support  
12 beams 176 that span the approximate inside diameter of the  
13 housing 112. As shown in Fig. 7c, the support beams 176  
14 are under the floor structure 150 and keep the floor  
15 structures 150 in place.

16 Fig. 7d is a cross-sectional view of the support beam  
17 176. The support beam 176 is substantially in the form of  
18 an "I" beam. A support plate 212 is attached to the "I"  
19 shaped support beam 176. The support plate 212 holds an  
20 angled floor support 214, which runs the length of the  
21 floor segments 158 such that the top of the floor segments  
22 is even with the top of the support beam 176. For an  
23 alternate embodiment, the floor segments 158 are made of a  
24 composite material. Also, for another alternative  
25 embodiment, the floor segments 158 are kept in place by  
26 gravity. This allows the user to remove and move the floor  
27 segments as desired. In yet another alternate embodiment,  
28 the floor segments may be secured in place with know  
29 methods including, for example, the use of nuts and bolts,  
30 VELCRO®, hooks and eyelets, ropes and eyelets, bolts and  
31 screws, snap-tight locking devices, or other types of  
32 fasteners.



1        Fig. 7e shows an angled top view of the floor segments  
2 158 in place and level with the top of the support beam  
3 176.

4        Turning now to Fig. 8, the first distal enclosure 122  
5 is displayed in a cross-sectional view. The first distal  
6 enclosure 122 has two substantially opposed opening 180;  
7 one at each of the longitudinal ends of the first distal  
8 enclosure. Between the openings 180 there is a passage  
9 128. The first distal enclosure 122 is connected to the  
10 housing 112 such that the openings 180 and passage 128  
11 provide the access to the internal volume 130 from outside  
12 of the housing. After entering the opening 180, there is a  
13 platform. In the preferred embodiment, the platform is a  
14 stepped platform 186 with steps 188 going down, a platform  
15 190, and steps 188 going upward to the first opening 116.

16        Fig. 8 also displays a number of cylinders 154  
17 disposed within the first distal enclosure 122. The  
18 cylinders 154 are fixedly attached to the inside of the  
19 first distal enclosure 122 by means of straps 182 that are  
20 attached to the inside surface of the first distal  
21 enclosure 122. In the preferred embodiment, the straps 182  
22 are made of a flexible metal, such as an aluminum alloy,  
23 are hingable, and have a clip 184 that is used to secure  
24 the cylinders 154 into place. The use of such straps 182  
25 allows for the movement of cylinders 154 as desired by the  
26 user as well as allowing the user to vary the number of  
27 cylinders 154.

28        Fig. 8 also illustrates the longeron retainers 142.  
29 The longeron retainers are secured to the first distal  
30 enclosure 122 by conventional means such as by welding or  
31 nuts and bolts. In the preferred embodiment, the longerons  
32 132 are made of aluminum or an aluminum alloy. The

1 longerons 132 fit within the longeron retainers 142 and are  
2 connected to by conventionally known means including the  
3 use of nuts and bolts, or epoxy based adhesives. In the  
4 instances where the longerons 132 are made of steel, the  
5 longerons are connected to the second distal enclosures by  
6 means of nuts and bolts, or by welding.

7 In alternative embodiment, the longerons 132 do not  
8 enter into the body of the first distal enclosure, but  
9 rather attach to the bulkhead 232.

10 Fig. 9 shows the second distal enclosure 126. The  
11 second distal enclosure 126 is attached to the housing 112  
12 in the same fashion as the first distal enclosure 122  
13 described above and can be accessed from the internal  
14 volume 130 through an opening 180. As the figure depicts,  
15 the second distal enclosure 126 stores supplies such as  
16 cylinders 154 and other items 192. The cylinders 154 are  
17 secured in place within the second distal enclosure 126 by  
18 the same methods as discussed above for the cylinders 154  
19 in the first distal enclosure 122. The other items 192 can  
20 take the form of electrical equipment, equipment stored  
21 within a container, food, medical supplies, or any other  
22 types of items used on the deployed module. While fig. 9  
23 illustrates a second distal enclosure 126 that is primarily  
24 used to store items, the second distal enclosure 126 is not  
25 limited to just storage.

26 The attachment of the longerons 132 are accomplished  
27 in the same manner as discussed above for the first distal  
28 enclosure 122.

29 The second distal enclosure 126 in Fig. 9 has a first  
30 end 194 with a first aperture 198 and a second end 196 that  
31 does not have an opening. The hollow interior 232 is where  
32 the cylinders 154 and other storage items are kept.

1        Fig. 9a is an illustration of the preferred embodiment  
2 of the second distal enclosure 126. The second distal  
3 enclosure 126 allows access to the internal volume 130 of  
4 the housing 112 in much the same way as was described as to  
5 the first distal enclosure 122. The second distal  
6 enclosure 126 has, a first aperture 198 at the first end  
7 194 and a second aperture 200 at the second end 196. These  
8 are the opposing openings 180. There exists a passageway  
9 204 within the hollow interior 202 and between the first  
10 aperture 198 and the second aperture 200. Thus, a  
11 crewmember can gain access into the internal volume 130  
12 from outside the second distal enclosure 126. As with the  
13 first distal enclosure 122, the second distal enclosure 126  
14 can also house cylinders 154 in the same way as the first  
15 distal enclosure 122 described above. In the preferred  
16 embodiment, the second distal enclosure 126 allows access  
17 into the internal volume 130 from outside of the modular  
18 human habitat simulator. As with the first distal  
19 enclosure, the second distal enclosure 126 has steps 188  
20 and a platform 190 for use by crewmembers.

21        Again, the longerons 132 can be attached to the second  
22 distal enclosure 126 in the same manner as described above  
23 for the first distal enclosure 122. That includes the case  
24 where longeron retainers 142 or a bulkhead 232 is used  
25 depending upon the application desired.

26        Focusing now on Fig. 10, the housing is composed of a  
27 number of housing segments 206. In the preferred  
28 embodiment, the housing segments 206 are made of steel.  
29 The housing 112 is assembled by securing the housing  
30 segments 206 together by conventional means such as  
31 welding.

1       Turning now to Fig. 11, a partially completed housing  
2 112 is displayed having been assembled by combining the  
3 housing segments . Addressing Fig. 12, the longerons 132  
4 fit within the housing 112 and into the first distal  
5 enclosure 122 and the second distal enclosure 126. The  
6 first and second distal enclosures are secured to the  
7 housing 112 by conventional means such as welding. The  
8 longerons 132 fit within longeron retainers 142 and are  
9 secured in place by conventional methods like welding or  
10 the use of epoxy based adhesives. In alternative  
11 embodiment, the longerons 132 are securely fixed to the  
12 bulkhead 232 by use of nuts and bolts, welding where the  
13 longerons 132 are steel, or the use of epoxy based  
14 adhesives.

15       There has thus been described a novel modular human  
16 habitat simulator. It is important to note that many  
17 configurations can be constructed from the ideas presented.  
18 The foregoing disclosure and description of the invention  
19 is illustrative and explanatory thereof and thus, nothing  
20 in the specification should be imported to limit the scope  
21 of the claims. Also, the scope of the invention is not  
22 intended to be limited to those embodiments described and  
23 includes equivalents thereto. It would be recognized by  
24 one skilled in the art the following claims would encompass  
25 a number of embodiments of the invention disclosed and  
26 claimed herein.

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